

Electronic supplementary information

**Strongly exchange coupled inverse
ferrimagnetic soft|hard, $\text{Mn}_x\text{Fe}_{3-x}\text{O}_4|\text{Fe}_x\text{Mn}_{3-x}\text{O}_4$, core|shell
heterostructured nanoparticles**

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EELS Analysis:

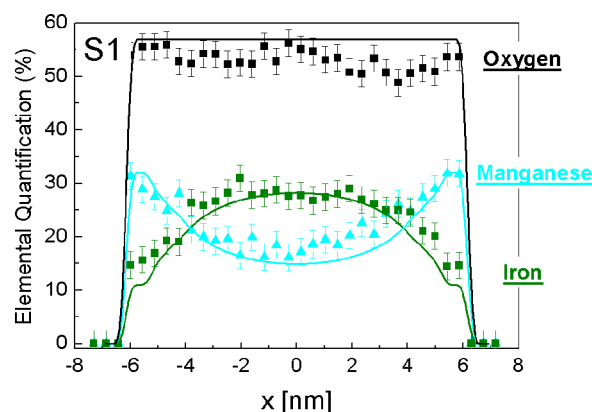


Fig. S1 Expected elemental quantification along the particle diameter for Fe (squares), Mn (triangles) and O (circles). The solid lines represent the simulated profile for a particle with a graded $\text{Mn}_{0.75}\text{Fe}_{2.25}\text{O}_4$ (8 nm)| $\text{Fe}_{1.75}\text{Mn}_{1.25}\text{O}_4$ (0.6 nm) shell 1|0.6 nm $\text{Fe}_{1.5}\text{Mn}_{1.5}\text{O}_4$ (0.6 nm) shell 2| $\text{Fe}_{0.75}\text{Mn}_{2.25}\text{O}_4$ (0.6 nm) shell 3 structure.

XAS and XMCD measurements:

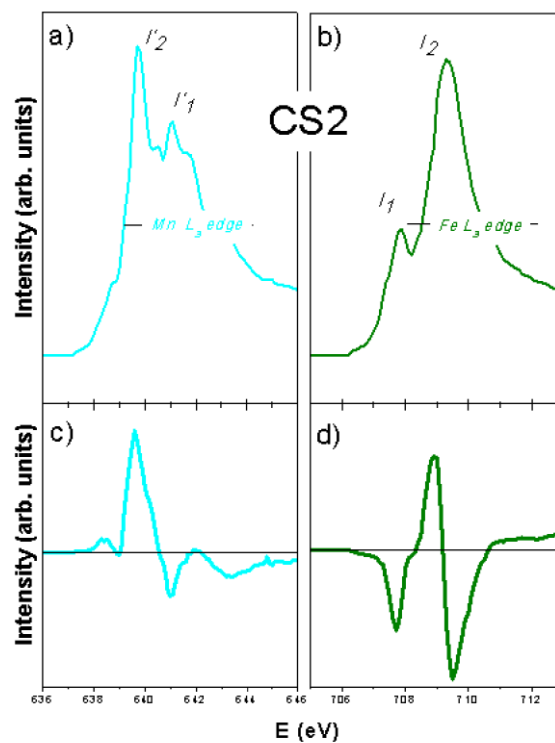


Fig. S2 (top) XAS and (bottom) XMCD spectra at the (left) Mn and (right) Fe edges of CS2 nanoparticles.

Magnetometry measurements:

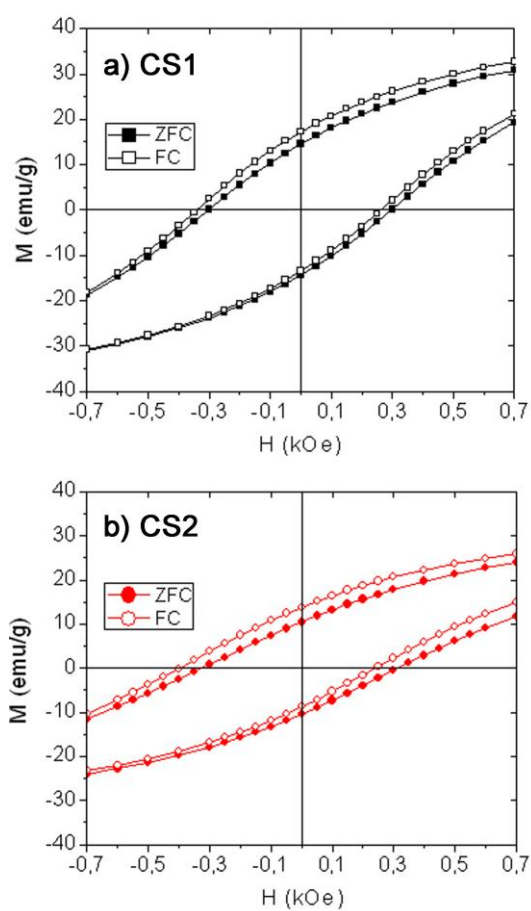


Fig. S3 Enlarged view at low fields of the FC and ZFC hysteresis loops, at 10 K, for (a) CS1 and (b) CS2 nanoparticles.